CAMBRIDGE
International Education

Cambridge International AS & A Level

CHEMISTRY **9701/31**

Paper 3 Advanced Practical Skills 1 **May/June 2024**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	'List rule' guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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Question	Answer	Marks
1(a)	**I** Three pieces of data shown • Two thermometer readings recorded **AND** temperature rise correctly calculated, all listed in the space provided, with units. • 'Correct' headings are not required for this mark, but it must be clear what the three figures refer to. • Ignore precision of readings (but see **II** of 1(c)(i)). • Do not award if either thermometer reading is below 10 °C. • Temperature units: / °C **OR** in °C **OR** (°C) **OR** °C by every reading.	**2**
	Accuracy mark Calculate the difference δ between temperature rises for supervisor and candidate. Supervisor value $\geqslant$ 10 °C, award mark **II** if $\delta \leqslant$ 1.5 °C. Supervisor value $\geqslant$ 5 °C and < 10 °C, award mark **II** if $\delta \leqslant$ 1.0 °C. Supervisor value < 5 °C, award mark **II** if $\delta \leqslant$ 0.5 °C.	
1(b)(i)	correctly calculates energy released energy = 50 × 4.18 × temp rise (J) **AND** answer given to 2–4 significant figures	**1**
1(b)(ii)	amount H_2SO_4 used = (0.030 × 2 × 0.5) = 0.03(000) (mol)	**1**
1(b)(iii)	correct use of data to calculate ΔH_1 $\Delta H_1 = {}^{\text{energy}}/_{1000} \times$ (b)(ii) **AND** answer must have negative sign **AND** be expressed to 2–4 significant figures	**1**

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Question	Answer	Marks
1(c)	**I** Six correct headings shown, with units, in list / table • (mass of) container + **FA 3** / solid / $NaHCO_3$ • (mass of) container (empty **or** with residual **FA 3**) • (mass of) **FA 3** / solid / $NaHCO_3$ **OR** mass used • initial temperature / thermometer reading • lowest / minimum / final temperature / thermometer reading • temperature change/decrease Mass units: / g **OR** in g **OR** (g) **OR** g by every reading Temperature units: / °C **OR** in °C **OR** (°C) **OR** °C by every reading **II** All readings shown to appropriate precision • all four balance / thermometer readings shown • all four thermometer readings [including those in 1(a)] to .0 or .5 • both masses to 2 decimal places **OR** both masses to 3 decimal places **III** Subtractions correct • mass of solid correct **AND** between 5.00–7.00 g • temperature fall correct **AND** between 8.0–12.0 °C	**3**
1(d)	Correct use of data expressions for M1 and M2 need not be evaluated to score **M1** energy = 25 × 4.18 × temp decrease **M2** amount of H_2SO_4 used = 0.5 × $^{\text{mass } NaHCO_3 \text{ used}}/_{84}$ (mol) **M3** enthalpy change = energy / amount of H_2SO_4 used × 1000 **AND** answer has positive sign **AND** expressed to two or more significant figures	**3**
1(e)	$\Delta H_r = 0.5\ \Delta H_1 - 0.5\ \Delta H_2 + \Delta H_3$	**1**
1(f)	(student is not correct) because acid is used in excess (in candidate's experiment (c)) (so temperature fall is unchanged)	**1**

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Question	Answer	Marks
2(a)	**I** The following data are recorded: • two burette readings **AND** titre for the rough titration • initial and final burette readings for two (or more) accurate titrations. **II** Titre values recorded for accurate titrations **AND** correct headings and units in the accurate titration table. • initial / start **AND** (burette) reading / volume • final / end **AND** (burette) reading / volume • titre **OR** volume used / added / **OR FA 4** used / added • unit: / cm^3 **OR** (cm^3) **OR** in cm^3 (for each heading) **OR** cm^3 unit given for each volume recorded. **III** All accurate burette readings recorded to 0.05 cm^3. **IV** The final accurate titre recorded must be within 0.10 cm^3 of any other accurate titre.	**7**
	Accuracy marks Check and correct titre subtractions. Select the 'best' titres using the hierarchy (ignoring the rough titre value): 2 identical titres, 2 titres within 0.05 cm^3, 2 titres within 0.10 cm^3, etc. Calculate candidate's mean titre to 2 decimal places. Calculate the difference δ between the candidate's titre and the supervisor's titre.	
	V Award if $\delta \leqslant 0.60$ cm^3 **VI** Award if $\delta \leqslant .0.40$ cm^3 **VII** Award if $\delta \leqslant 0.20$ cm^3	
2(b)	Candidate calculates mean titre correctly to 2 decimal places • Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm^3. • Working/ explanation must be shown **OR** ticks must be put next to the two (or more) accurate readings selected. • The mean should be quoted to 2 decimal places and be rounded to the nearest 0.01 cm^3.	**1**
2(c)(i)	All answers given for **(c)(ii)**, **(iii)**, **(iv)** and **(v)** given to 3 or 4 significant figures.	**1**
2(c)(ii)	Correctly calculates amount of sodium thiosulfate used = $^{14.24}/_{158.2} \times {}^{\text{mean titre}}/_{1000}$ (mol)	**1**

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Question	Answer	Marks
2(c)(iii)	Correct use of 2(c)(ii) amount of iodine (in 1 dm^3) = $^{(c)(ii)}/_{2} \times {}^{1000}/_{25}$ (mol)	**1**
2(c)(iv)	Correct use of 2(c)(iii) amount of iodine reacting with sodium sulfite = 0.0600 – (c)(iii)	**1**
2(c)(v)	Correct use of 2(c)(iv) M_r of sodium sulfite = $^{5.0}/_{(c)(iv)}$	**1**
2(c)(vi)	Correct use of 2(c)(v) $x = {}^{[(c)(v) - 126.1]}/_{18}$ answer must be correctly rounded to an integer	**1**

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Question	Answer	Marks
	FA 7 is $AgNO_3(aq)$, **FA 8** is $CH_3COOH(aq)$, **FA 9** is $HCl(aq)$, **FA 10** is $MgSO_4(aq)$ and **FA 11** is $Zn(NO_3)_2(aq)$.	
3(a)(i)	**M1** adds Mg to **FA7**: records dark grey / black **AND** solid / precipitate / deposit / coating / layer **M2** adds Mg to **FA8** and **FA9**: records fizzing / effervescence in both reactions **M3** clear indication that the reaction with magnesium of **FA9** is faster / more vigorous than the reaction with magnesium of **FA8** (ORA) **M4** *Any one of the following:* • (gas) pops with lighted splint in either the Mg / **FA8** or Mg / **FA9** reactions • Mg dissolves / disappears **AND** colourless solution formed / heat produced in either the Mg / **FA8** or Mg / **FA9** reactions • white precipitate forms when **FA7** and **FA9** are mixed. **M5** all three identities correct: **FA7** = $AgNO_3$, **FA8** = CH_3COOH and **FA9** = HCl	**5**
3(a)(ii)	$Mg(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$	**1**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(b)(i)</td><td>
<table>
<tr><td></td><td>FA10</td><td>FA11</td></tr>
<tr><td>Test 1
NH_3</td><td>• white ppt AND insoluble in excess</td><td>• white precipitate
• soluble in excess</td></tr>
<tr><td>Test 2
Ba^{2+}</td><td>• white precipitate
AND</td><td>• no reaction / no change / no ppt
AND</td></tr>
<tr><td>HCl</td><td>(white ppt) insoluble / no change</td><td>no reaction / no change no ppt</td></tr>
<tr><td>Test 3
NaOH</td><td>• white ppt AND insoluble in excess</td><td>• white precipitate
• soluble in excess</td></tr>
<tr><td>Heat</td><td colspan="2">Ignore anything written in either of these boxes, unless any positive gas test is recorded (including “litmus goes red”), in which case it contradicts the gas test bullet in the box below the gas test – mark by column.</td></tr>
<tr><td>+ Al</td><td>• fizzing / effervescence
• (gas) pops with a lighted splint
OR gas does not turn (red) litmus blue</td><td>• fizzing / effervescence
• gas turns (red) litmus blue.</td></tr>
</table>
Two points needed for each mark.</td><td>5</td></tr>
<tr><td>3(b)(ii)</td><td>
<table>
<tr><td></td><td>cation</td><td>anion</td></tr>
<tr><td>FA 10</td><td>• Mg^{2+}</td><td>• SO_4^{2-}</td></tr>
<tr><td>FA 11</td><td>• Zn^{2+}</td><td>• unknown</td></tr>
</table>
Two points needed for each mark.</td><td>2</td></tr>
</table>

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